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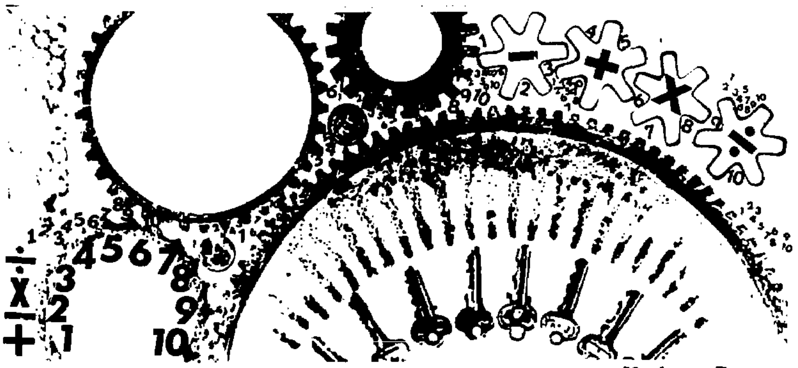
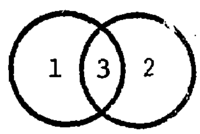
ABSTRACT

This bulletin provides a review of research related to teaching mathematics to disadvantaged students at the elementary school level. The review is organized around a set of questions which are appropriate to ask in relation to disadvantaged students. These questions include: 1) What is the mathematical status of the environmentally disadvantaged? 2) What do evaluations of Head Start programs show? 3) Are there mathematical characteristics which distinguish the academically disadvantaged? 4) Do special mathematics programs for environmentally disadvantaged students make a difference? 5) Are programs for low achievers effective? 6) What teaching procedures are most effective for slow learners? 7) Are different materials appropriate for the disadvantaged? 8) What remedial procedures have been effective? 9) How are personality characteristics of the disadvantaged related to achievement? Answers to these questions are provided by a variety of research studies. A selected list of references is provided. (FL)



MATHEMATICS AND THE "DISADVANTAGED"

Who are the "disadvantaged"? The word is used in a variety of ways, to suit a variety of situations. In this bulletin, the term will be used in connection with two intersecting sets of students.



1 - Environmentally disadvantaged students. Cultural factors such as socio-economic level (SES) or migrant status determine inclusion in this set.

2 - Academically disadvantaged students. Factors such as intellectual ability and achievement also cause students to be disadvantaged. This set includes the "low achiever" (e.g., the pupil who ranks in the lower third of the student population on mathematics or general achievement) and the "slow learner" (e.g., the student with an IQ of 75 to 90). And then there are the "underachievers", who appear to have the ability to achieve at a higher level, but fail to do so.

3 - The above two sets are not disjoint: some students are both environmentally and academically disadvantaged.

All in all, research has given us limited guidance in knowing how to provide the most effective mathematics programs and instruction for disadvantaged students. Little of the knowledge we do have regarding such students comes from research conducted explicitly within the context of mathematics education.

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While it would seem that questions asked in previous bulletins (Suydam and Weaver, 1970) are appropriate to ask in relation to the disadvantaged, not much valid research has been done to answer many of those questions. It has been necessary to organize this bulletin around a different set of questions, with answers frequently coming from studies in which the specific groups investigated were not defined consistently in the same way.

An attempt has been made to take into consideration the variability in the quality of research as this bulletin was prepared.

1. *What is the mathematical status of the environmentally disadvantaged?*

The majority of studies with the environmentally disadvantaged are status studies, providing descriptive information on how students were achieving at the time of the study. Some studies, however, have compared the achievement of pupils from two or more levels. Thus, Montague (1964) reported that kindergarteners from a high SES area scored significantly higher on an inventory of mathematical knowledge than pupils from a low SES area. Dunkley (1965) similarly reported that achievement of pupils from disadvantaged areas was generally below that of children from middle-class areas. Differences were greater in first grade than in kindergarten, indicating that there may be a cumulative effect attributable to being disadvantaged.

Johnson (1970) noted that kindergarteners from low SES backgrounds demonstrated less ability to categorize consistently on attribute resemblance. Regardless of SES-level, similar stages of development were indicated, but students of low SES may proceed through the stages at a slower pace.

In studies of children's ability to conserve number (in grade 1) or quantity (in grade 4), low SES pupils almost invariably achieved significantly less than high SES pupils. No differences in the ability to conserve, however, were found between racial groups, whether white, Negro, or Indian.

Cleveland (1962) found, in a survey of sixth graders, that mathematical achievement at all IQ levels was positively correlated with SES.

Pattison and Fielder (1969) reported that, on tests of number concepts using manipulative materials, kindergarten children who attended non-Title I schools scored significantly higher than those disadvantaged pupils who were in Title I schools. Differences between bilingual and monolingual children on three of five subtests were also significant.

In general, mobility has not been found to affect achievement significantly.

2. *What do evaluations of Head Start programs show?*

While most Head Start programs are not by intention academically oriented, some studies have attempted to measure the effects of such programs on later achievement. For instance, Mackey (1969) reported that, generally, children who had a Head Start program scored significantly higher on arithmetic tests at the end of first grade than qualified pupils who did not participate in Head Start.

3. *Are there mathematical characteristics which distinguish the academically disadvantaged?*

Achievement and ability appear to be related: the greater one's intellectual ability is, the higher his achievement is apt to be.

Beldin (1960) found that sixth grade high and low achievers differed significantly in their ability to solve problems with unnecessary data, no numbers, and missing data, but did not differ on three other problem solving techniques (designating the process, selecting problems to fit a given example, and selecting the question).

A consistent pattern of errors was found among the sixth-grade low achievers studied by Schacht (1967). These error patterns were observed in six areas: diagrams, complex and involved questions, numerals and number systems, measurement, fraction concepts, and geometry. The low achievers had less difficulty with computation than with concepts involving reasoning.

Asbury (1970) noted some differences between first grade over- and under-achievers (in rural economically deprived areas) on subtests measuring numerical concepts, but found no differences between Negro and white pupils.

4. *Do special mathematics programs for environmentally disadvantaged students make a difference?*

It is not at all surprising to find studies which report that special programs designed to provide special treatments and emphases for disadvantaged pupils result in higher achievement when compared with "regular" programs which include no special provisions for such pupils!

Dethmers (1969) identified two groups of fifth and sixth grade children from "lower class family backgrounds" (defined by "economic deprivation") who were also comparable on indices of "educational deprivation", achievement level, ability, and educational experience. In one school, four innovative features were implemented: team-planned instruction, departmentalization, individualization, and contracts based on diagnosis. In another school, children were in self-contained classrooms and used "conventional instructional materials". Those in the innovative program scored significantly higher on the arithmetic section of a standardized test than did those in the other program.

A mathematics program "specially designed for culturally disadvantaged pupils", emphasizing success experiences, careful development of concrete to abstract levels, use of simple language, reduced reading level and load, and such techniques as discovery, inquiry and experiments in the fourth grade in inner-city schools was compared with a "regular" program. Significant differences favored the experimental group on measures of concepts and overall achievement, and gains for the experimental group were greater than for the regular group on computation and application measures (Hankins, 1969).

Castaneda (1968) designed a mathematics program for Mexican-American first graders which took into account the need to progress from (1) perceptual to conceptual levels, (2) sensory to language conceptualization, and (3) lower- to

higher-order concepts, with the intrinsic motivation of success capitalized upon. The group using this program showed greater gains than a group using a "regular" program.

Lerch and Kelley (1966) reported that seventh-graders in a mathematics program for slow learners, in which intraclass grouping and a topical approach adjusted to individual needs were used, achieved more than those in "regular" classes.

Dreyfuss (1969) developed a special junior high program which included activities such as field trips, individual and small group work, weekly evaluation by counselors, programmed texts, records, tapes, tutor help, and guest speakers. The program produced significantly higher achievement in mathematics than that attained by a control group.

Liederman, Chinn, and Dunkley (1966), in a pilot project undertaken to evaluate the learning of SMSG materials by culturally disadvantaged pupils, reported wide variability in achievement both within and between classes at kindergarten and first grade levels. Such variability must be considered: even among disadvantaged pupils, individual differences exist.

5. *Are programs for low achievers effective?*

The findings of research on grouping on the basis of achievement have been much more variable than those for grouping on the basis of ability. Differentiated instruction appears, however, to be more effective than total class instruction.

Easterday (1964) reported on "modern" (SMSG) and "traditional" mathematics materials which were organized into a program for low achievers in grades 7 and 8. Achievement made on a standardized test indicated that these students made a "normal" increase over the school year.

Sherer (1968) found that low achieving pupils in grades 3 through 7 taught by author-developed materials, using instructional aids such as drawings, counters, and number lines and charts, showed significantly greater gain in arithmetic achievement than those taught by a traditional procedure.

DeVenney (1969) found that a special program developed for low achievers did not improve pupils' computational skills to as high a degree as a traditional program, but it did result in attitudes which changed from negative to positive.

Hillman (1970) found that fifth graders given immediate knowledge of results, either with or without candy reinforcement, scored significantly higher than pupils not given knowledge of results until 24 hours later. Low achievers may profit more than high achievers.

6. *What teaching procedures are most effective for slow learners?*

Anastasiow et al. (1970) reported that kindergarteners with low scores on a picture vocabulary test learned classification tasks best with a rule-example method, while others did equally well with a guided discovery method. Miller (1957) found that methods emphasizing "meaning" were less effective than methods emphasizing "rules" for bilingual seventh grade children with low IQ's.

Klausmeier and Check (1962) concluded that when children, whether of low, average, or high intelligence, receive learning tasks appropriately graded to their levels of achievement, they retain and transfer equally well to new situations of appropriate difficulty.

Herriot (1968) found that when pupils in grades 7 and 9 who were classified as slow learners studied SMSG material for two years, they achieved a greater gain than a higher ability control group achieved in one year. It was concluded that time does make a difference but the question of the optimum time needed by slow learners to reach satisfactory levels of achievement has not been answered.

Grouping on the basis of ability has been found to be less effective for those at lower ability levels than for those at upper ability levels. Perhaps this finding is confounded by the use of materials and methods that are not differentiated for these two ability groups.

7. *Are different materials appropriate for the disadvantaged?*

It has been suggested that the use of varied aids, media, and materials, along with real-life experiences and laboratory techniques, is especially effective with disadvantaged groups. Schippert (1965) found that, in an inner-city school, use of a laboratory approach in which seventh graders manipulated actual models or representations of mathematical principles resulted in significantly higher achievement on measures of skills than students taught by a discovery-oriented approach using verbal or written descriptions of those principles. Howard (1970) used mathematics laboratory experiences, planned "to facilitate a hierarchy of needed concepts", with environmentally and academically disadvantaged rural children. Such experiences resulted in both achievement and attitudinal gains.

Achievement when programmed instruction materials were used with groups of disadvantaged children was reported to be not significantly different than when conventional materials were used.

8. *What remedial procedures have been effective?*

In most cases, we aren't given sufficient specific information in research reports about the nature of remedial programs. We do know, however, that diagnosis and individualization are effective procedures to incorporate into remediation efforts.

Bernstein (1956) found that special practice material based on diagnosis of individual student error produced significant gain in achievement. During the second phase of his study, ninth graders needing remedial instruction attended a mathematics clinic for one semester of individual instruction. This technique seemed to be more effective than grouping these pupils into one class.

Olsen (1969) reported that use of volunteer tutors with boys in grades 2, 3, and 4 who were under-achievers, and who also were achieving two or more months below grade level, resulted in no significant differences on most measures of self-concept, achievement, and intelligence. At the third grade level, however, those tutored in arithmetic achieved significantly more than those not tutored.

Some evidence exists that the use of "learning resource teachers" and "floating teachers" helps to increase mathematics achievement for academically disadvantaged students.

9. *How are personality characteristics of the disadvantaged related to achievement?*

Analysis of scores on personality tests has failed to indicate many characteristics in which the environmentally disadvantaged differ from other population groups. However, some personality factors appear to be related to achievement. To measure various dimensions of behavior among under-achievers of average or above average IQ, a battery of tests, interviews, checklists, and screening devices was used with sixth graders by Ross (1964). He found that they characteristically were withdrawn and defeated in attitudes toward school and society, while a majority of the causes of underachievement seemed emotional in nature. Cleveland (1962) found significant relationships between personality factors and level of achievement when SES was controlled.

Feldhusen and Klausmeier (1962) reported significantly greater mean anxiety in the low IQ group than in the average or high groups studied in grade 5. Significant correlations were found between anxiety and arithmetic achievement only in the low IQ group.

At the fourth and sixth grade levels, Capps (1962) found no significant difference on a personality test between high achieving and low achieving pupils. Poor achievement in arithmetic tended to be related to personal adjustment.

Traweek (1964) found that fourth graders who were unsuccessful with programmed materials scored significantly higher on personality subtests indicating greater withdrawal tendencies and less self-reliance.

10. *In summary* . . .

a. The disadvantaged, as well as all other pupils, profit from special attention. This may be in the form of attention from the teacher, the content of the program, the instructional materials, the organization for instruction.

b. The mathematical characteristics which distinguish disadvantaged from advantaged pupils appear to exist in degree rather than kind. That is to say, disadvantaged and advantaged pupils have similar abilities and skills, but differ in depth or level of attainment.

c. Rate of learning is but one variable to be considered in providing effective instruction for slower learners. Methods and materials of instruction also must be adapted to these pupils.

d. Social relevance appears to be more crucial to consider in the case of disadvantaged students; however, little research has attended to this topic.

e. The degree of meaning (in the mathematical sense) which is optimal for disadvantaged students is an unknown factor. While there is some evidence that

"discovery" approaches are not as effective as "rule" approaches with low achievers, it may merely be that more-closely-guided discovery and lower levels of meaning are appropriate for these groups.

f. Active physical involvement with manipulative materials, which is believed to be important for all children, may be even more so for the disadvantaged.

g. Pupils who are disadvantaged mathematically may also be disadvantaged in other factors which are related to their mathematical learning (e.g., reading ability). Such things must be taken into account in planning the curriculum for the disadvantaged child.

h. It does little good to report that special programs for disadvantaged students are effective without also reporting in detail the specific nature of those programs. More evidence on "ideas which work", as well as research, is needed.

i. Groups of disadvantaged pupils are not all disadvantaged in the same way. There is as much need to individualize instruction for disadvantaged students as for other groups of students.

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